

Thermal Vacuum Verification of Origami Inspired Radiators

Completed Technology Project (2017 - 2018)



Project Introduction

This effort seeks to provide a unique means of modulating the waste thermal energy radiated by a radiator, and represents a restart of the FY17 effort that had to be terminated early. Two concepts are combined; use of custom, multimaterial-layered films (deposited via conventional sputtering methods and Atomic Layer Deposition (ALD)) and the ability to "fold" the radiator employing origami techniques. The ALD coating technique is new to this radiator application, and has well established stability in electrostatic charging environments. This technology is applicable to the full spectrum of spacecraft platforms from large structures to 1 U CubeSats. Current technology undergoes a solid-state transition at 68 C, which is generally too high to be useful. This CIF will seek to achieve a lower transition temperature through use of an innovative, multi-layered structure involving selective reflectance interference layers, applied via ALD. The material of choice for this interference layer is TiO₂ with Ge. Theoretically, the proposed coating results in a surface that transitions around 2 C with a low $e = .1$ and a high $e = .85$, and a 5% reversible hysteresis. This coating will be tested to demonstrate performance. Additionally, as a second innovation, this novel coating will be applied onto origami inspired radiators, currently under development at BYU. Fabrication and characterization testing of this variable emissivity, 3D radiator will be performed at GSFC by the end of the FY.

Anticipated Benefits

Once successfully demonstrated in a space environment this technology will allow variable capacity for radiators, thus reducing the need for make-up electric power or other technologies which carry a mass penalty.



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Origami Inspired Radiators

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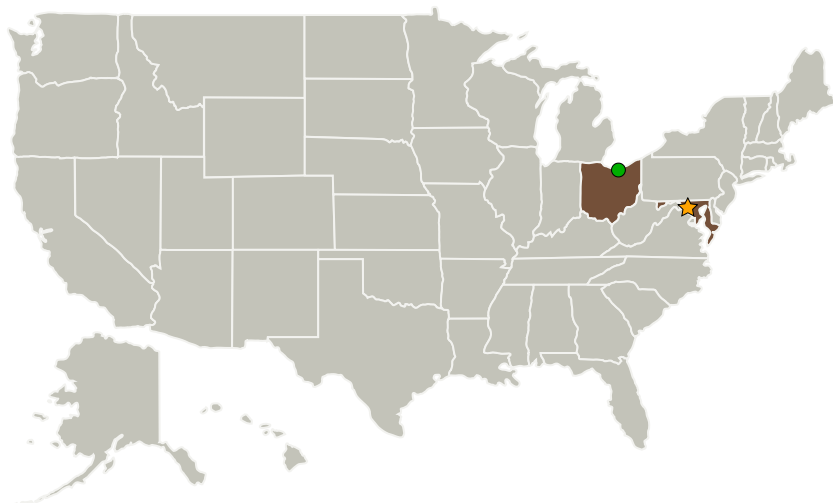
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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Goddard Space Flight Center (GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland
Brigham Young University-Provo	Supporting Organization	Academia	Provo, Utah
● Glenn Research Center (GRC)	Supporting Organization	NASA Center	Cleveland, Ohio
University of Maryland-College Park (UMCP)	Supporting Organization	Academia Asian American Native American Pacific Islander (AANAPISI)	College Park, Maryland

Primary U.S. Work Locations

Maryland	Ohio
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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Innovation Fund: GSFC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

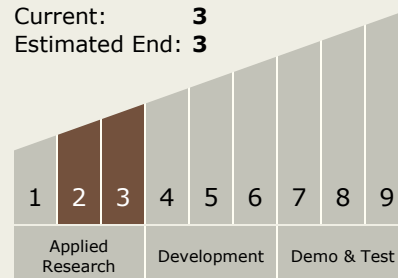
Peter M Hughes

Principal Investigator:

Vivek H Dwivedi

Technology Maturity (TRL)

Start: 2
 Current: 3
 Estimated End: 3



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Project Transitions



October 2017: Project Start



September 2018: Closed out

Closeout Summary: Conventional thermal-control systems for satellites, from large platforms to miniaturized science structures (e.g., CubeSats), may result in a design that has excessive mass. This CIF demonstrates a design alternative by testing a passive, multifunctional, modulating smart radiator device (SRD) based on origami folds. The smart radiator can be folded to adjust its effective area, thus modulating its capacity in an intelligent manner. This concept will verify a 3-D state-of-the-art thermal radiator, which results in an estimated 10-15% decrease in the overall spacecraft power budget. The work was performed in collaboration with Brigham Young University (BYU), which is sharing in development costs by providing manpower and a radiator prototype.

Project Website:

https://www.nasa.gov/directorates/spacetech/innovation_fund/index.html#.VQ

Technology Areas

Primary:

- TX14 Thermal Management Systems
 - └ TX14.2 Thermal Control Components and Systems
 - └ TX14.2.3 Heat Rejection and Storage

Target Destinations

Earth, Others Inside the Solar System, Outside the Solar System